Name Changes in the *Mentzelia multicaulis* Complex (Loasaceae)

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Abstract. Results from molecular phylogenetic analyses indicate that three varieties of *Mentzelia multicaulis* (Osterhout) J. Darlington (Loasaceae) are more closely related to other species of *Mentzelia* sect. *Bartonia* Torrey & A. Gray than to *M. multicaulis* var. *multicaulis*. We elevate three varieties of *M. multicaulis*, originally described from Utah, to specific rank, recognizing them as *M. librina* (K. H. Thorne & F. J. Smith) J. J. Schenk & L. Hufford, *M. flumensevera* (N. H. Holmgren & P. K. Holmgren) J. J. Schenk & L. Hufford, and *M. uintahensis* (N. H. Holmgren & P. K. Holmgren) J. J. Schenk & L. Hufford. Both stamen and leaf shape characters support evolutionary relationships of these species with their closest relatives among the mentzelias found in the Intermountain West of the United States.

Key words: Intermountain West, Loasaceae, *Mentzelia*, United States, Utah.

Mentzelia L. (Loasaceae) has its greatest taxonomic and morphological diversity in western North America. Much of this diversity is centered in *Mentzelia* sect. *Bartonia* Torrey & A. Gray, which has presented considerable taxonomic problems (Holmgren & Holmgren, 2002). Recent studies of mentzelias in the Intermountain West have expanded our knowledge of morphological diversity and increased substantially the number of recognized taxa in *Mentzelia* sect. *Bartonia* to approximately 50 species (Thompson & Prigge, 1984, 1986, 2004; Prigge, 1986; Thorne, 1986; Thorne & Smith, 1986; Christy, 1997, 1998; Holmgren & Holmgren, 2002; Reveal, 2002; Welsh et al., 2003; Holmgren et al., 2005).

Some of the recently discovered diversity in *Mentzelia* sect. *Bartonia* has been circumscribed as varieties of *M. multicaulis* (Osterhout) J. Darlington (Thorne & Smith, 1986; Holmgren & Holmgren, 2002). Osterhout (1903) first used the specific epithet *multicaulis* in *Touterea* Eaton & Wright to denote collections from Eagle County, Colorado, on the western slope of the Rocky Mountains. *Touterea* was later combined with *Mentzelia* by Darlington (1934). The concept of *M. multicaulis* was expanded by Thorne and Smith's (1986) description of *M. multicaulis* var. *librina* K. H. Thorne & F. J. Smith. This endemic of the Book Cliffs of eastern Utah was distinguished from *M. multicaulis* var. *multicaulis* as a more robust plant with trilobed rather than pinnatifid to linear leaves and shorter seeds (Thorne & Smith, 1986). Holmgren and Holmgren (2002) further expanded the concept of *M. multicaulis* with the description of the varieties *uintahensis* N. H. Holmgren & P. K. Holmgren and *flumensevera* N. H. Holmgren & P. K. Holmgren. Holmgren and Holmgren (2002) recognized the four varieties of *M. multicaulis* as sharing a subshrubby habit comprised of shoots with many zigzagged branches arising from a subterranean, woody caudex and possessing short (1.5–3[–5] cm) cauline leaves that are deeply pinnatifid with three to seven (to 11) segments or entire, flowers that have five, broadly spatulate or suborbicular, shortly clawed petals that are 9–20 × 2–9(–11) mm and five petaloid stamens that are 7–12(–15) × 1.2–7(–9) mm, and seeds with coats that have straight anticlinal walls and three to 10 papillae per cell among other traits.

Holmgren and Holmgren (2002) also called attention to several other *Mentzelia* species of the American Intermountain West, including *M. argillicola* N. H. Holmgren & P. K. Holmgren, *M. argillosa* J. Darlington, *M. rhizomata* Reveal, and *M. shultziorum* Prigge, that shared many morphological attributes with, and were geographically close to, one or more of the *M. multicaulis* varieties. These Intermountain species, like *M. multicaulis*, were also found on steep slopes of talus or otherwise loose substrate. Our molecular phylogenetic studies, which have broadly sampled species of *Mentzelia* sect. *Bartonia* for variation in sequences of the ITS-1 and ITS-2 and the ETS region of nuclear ribosomal DNA, recovered a paraphyletic *M. multicaulis* sensu Holmgren and Holmgren (2002). Our results showed the varieties of *M. multicaulis* to be more closely related to other Intermountain West species than to each other (Schenk & Hufford, in prep.). For example, *M. multicaulis* var. *multicaulis* was recovered as sister to *M. rhizomata*, *M. multicaulis* var. *librina* was sister to *M. shultziorum*, *M. multicaulis* var. *uintahensis* was sister to the *M. multicaulis* var. *librina* and *M. shultziorum* clade, and *M. multicaulis* var. *flumensevera* was sister to *M. argillicola*. Based on the robust phylogenetic signal, including substantial patristic

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distance among the varieties of *M. multicaulis*, and the morphological distinctiveness of the species most closely related to the different varieties of *M. multicaulis*, we elevate the varieties *flumensevera*, *librina*, and *uintahensis* of *M. multicaulis* to specific rank.

1. **Mentzelia multicaulis** (Osterhout) J. Darlington, Ann. Missouri Bot. Gard. 21: 156. 1934. Basionym: *Touterea multicaulis* Osterhout, Bull. Torrey Bot. Club 30: 237. 1903. TYPE: U.S.A. Colorado: Eagle Co., Wolcott, 11 July 1902, *G. E. Osterhout 2663* (holotype, RM; isotypes, CAS, COLO, NY, POM, RM).

Distribution and habitat. *Mentzelia multicaulis* occurs on the western slope of the Rocky Mountains, in Eagle, Summit, and Grand counties, Colorado. It occurs on sparsely vegetated slopes at 1800–2600 m elevation.

Relationships. *Mentzelia multicaulis* is most closely related to *M. rhizomata*, which is also distributed on the western slope of the Colorado Rocky Mountains. The variety *multicaulis* was distinguished from the other varieties by, among other traits, its much broader petals (5–9 mm; measurements from Holmgren & Holmgren, 2002) and the width of its median antesepalous stamens (the single outermost stamen directly opposite each sepal, sensu Hufford [1990, 2003]; 2–3.5[–4.5] mm). *Mentzelia rhizomata* is similar in possessing broad petals (6.1–9.6[–11.2] mm) and slightly wider median antesepalous stamens (4.2–6.2 mm). The basal leaves of *M. multicaulis* are lobed, whereas the more distal leaves are less prominently lobed to entire (Fig. 1A). The basal leaves of *M. rhizomata* are less prominently lobed, having undulate to toothed margins, and, like *M. multicaulis*, have more distal leaves that are usually entire (Fig. 1B).

Additional specimens examined. U.S.A. **Colorado:** Eagle Co., on hills 0.3 mi. N of Walcott [Wolcott], *H. J. Thompson 3205* (UTC); Colorado River Canyon, State Bridge, N of bridge, *N. H. Holmgren & P. K. Holmgren 14486* (NY, UTC); along State Rte. 9, 0.8 km N of Summit Co. line, 17.4 km S of downtown Kremmling, *N. H. Holmgren & P. K. Holmgren 15062* (NY, UTC); State Rte. 131, 12.7 km N of Wolcott, *N. H. Holmgren & P. K. Holmgren 14485* (NY, UNLV, UTC, WS); N of Wolcott along State Rte. 131, 0.5 km N of Eagle River bridge, *N. H. Holmgren & P. K. Holmgren 14484* (NY, RENO, UTC); along Colorado Hwy. 131, 0.4 mi. N of U.S. Hwy. 6 at Wolcott, *J. L. Reveal 7246* (NY); Wolcott, *Bessey 5290* (NY); E rim of Dotsero Crater, 1 mi. NE of Dotsero, *W. Baker & T. Naumann 82-370* (NY); Rte. 131, just N of Wolcott on E side of rd., *J. Schenk 1867* (WS); Rte. 1, just N of jct. with Colorado River, *J. Schenk 1884* (WS). Grand Co., S of Kremmling, 1.8 mi. SW on Co. Rd. 1 from Rte. 9, *K. W. Eberle 495* (UTC); Red Mtn., 1.5 mi. E of Kremmling, *B. E. Neely 5166* (UTC); W side of Muddy Creek, 2 mi. NNW of Kremmling, *E. Neese & O. Grah 17166* (NY); Sulphur Springs, *G. E. Osterhout 3562* (NY); Rte. 191, just N of intersection w/Rte. 1, *J. Schenk 1894* (WS). Summit Co., SE end of Green Mtn. Reservoir, along State Rte. 9, 10.8 km S of Grand Co. line, *N. H. Holmgren & P. K. Holmgren 15061* (NY, UTC).

2. **Mentzelia flumensevera** (N. H. Holmgren & P. K. Holmgren) J. J. Schenk & L. Hufford, stat. nov. Basionym: *Mentzelia multicaulis* (Osterhout) J. Darlington var. *flumensevera* N. H. Holmgren & P. K. Holmgren, Syst. Bot. 27: 761. 2002. TYPE: U.S.A. Utah: Piute Co., Sevier River, in a small draw W of U.S. Hwy. 89, 5.5 km N of downtown Marysvale, 1900 m, on SW-facing, fine gravel talus, 18 Aug. 2001, *N. H. Holmgren & P. K. Holmgren 14507* (holotype, NY; isotypes, BRY, COLO, NY, RM, UTC, WS).

Distribution and habitat. *Mentzelia flumensevera* is narrowly distributed along the Sevier River Canyon in the Tushar Mountains of Piute County, Utah. *Mentzelia flumensevera* occurs between 1800 and 1900 m elevation on steep south- or southwest-facing talus slopes comprised of gypsum-rich soils.

Relationships. *Mentzelia flumensevera* is most closely related to *M. argillicola*, which is located in Lincoln County, Nevada. Populations of *M. argillosa*, which is sister to the *M. flumensevera* and *M. argillicola* clade (Schenk & Hufford, in prep.), are found as close as 30 km to the northeast of *M. flumensevera* in Sevier and Sanpete counties, Utah. Like *M. flumensevera*, both *M. argillicola* and *M. argillosa* occur on gypsum-rich substrates.

Median antesepalous stamens that have petaloid forms in which the filaments are narrowly spatulate to oblanceolate with attenuate bases have been used to distinguish the *Mentzelia multicaulis* varieties *flumensevera* and *multicaulis* from *librina* and *flumensevera* (Holmgren & Holmgren, 2002; Holmgren et al., 2005). These stamen characters are also found in *M. argillicola* and *M. argillosa*, most likely due to their common evolutionary history. The leaf margins of *M. argillosa* (Fig. 1C) are mostly entire and similar leaf forms are found on the shoots of *M. argillicola* (Fig. 1D), although some of the more distal leaves of the latter are shallowly lobed. *Mentzelia flumensevera* differs from its closest relatives in having leaves that are distinctly lobed over the length of the shoot system (Fig. 1E). Leaves of all three of these species appear grayish green due to their copious trichomes.

Additional specimens examined. U.S.A. **Utah:** Piute Co., Tushar Mtns., Big Rock Candy Mtn., *A. Taye 4241* (RM); Marysvale Canyon, ca. 2.7 mi. NNW of Marysvale, *A. Taye 3424* (NY, RM); Sevier Canyon, along U.S. Hwy. 89, 7 km N of downtown Marysvale, W of hwy., *N. H. Holmgren & P. K.*

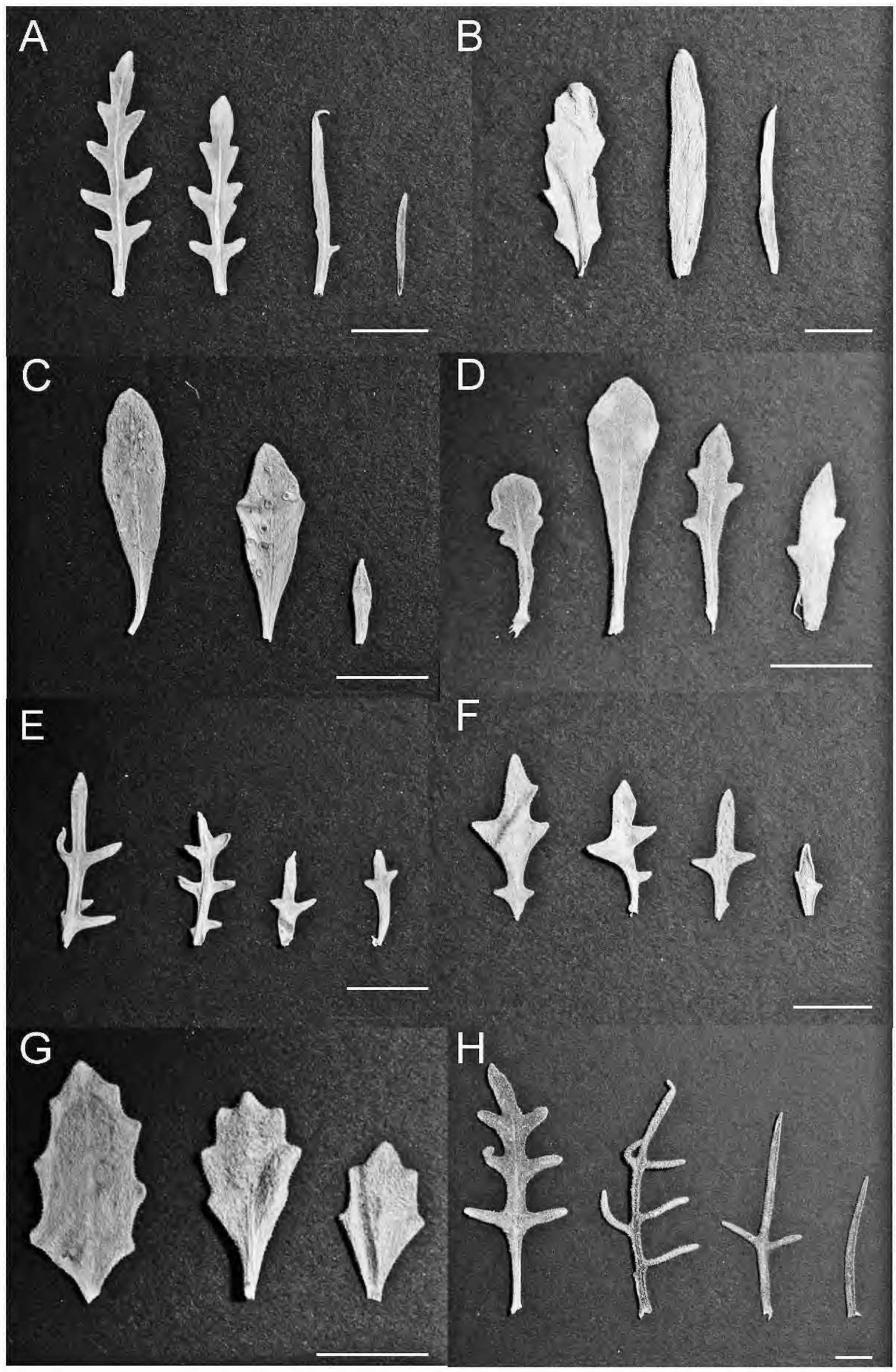

Figure 1. Leaves of species in the *Mentzelia multicaulis* complex. Leaf forms vary over the length of shoot systems and leaves from the basal, mid, and distal portions of shoots are shown (left to right, respectively). —A. *Mentzelia multicaulis* (U.S.A., Colorado, *J. Schenk 1878*, WS). —B. *M. rhizomata* (U.S.A., Colorado, *Hufford 4135*, WS). —C. *M. argillosa* (U.S.A., Utah, *Schenk 1746*, WS). —D. *M. argillicola* (U.S.A., Nevada, *Schenk 1192*, WS). —E. *M. flumensevera* (U.S.A., Utah, *Schenk 1745*, WS). —F. *M. librina* (U.S.A., Utah, *Schenk 1865*, WS). —G. *M. shultziorum* (U.S.A., Utah, *Hufford 4140*, WS). —H. *M. uintahensis* (U.S.A., Utah, *Schenk 1532*, WS). Scale bars = 1 cm.

Holmgren 14460 (NY, RENO, UTC, WS); along Hwy. 89, 3.4 mi. N of jct. of Bullion Ave. & Hwy. 89 in Marysvale, *L. Hufford 4147* (WS); Hwy. 89, 3.4 mi. N of Marysvale in small ravine on W side of rd., *J. Schenk 1744* (WS).

3. Mentzelia librina (K. H. Thorne & F. J. Smith) J. J. Schenk & L. Hufford, stat. nov. Basionym: *Mentzelia multicaulis* (Osterhout) J. Darlington var. *librina* K. H. Thorne & F. J. Smith, Great Basin Naturalist 46: 556. 1986. TYPE: U.S.A. Utah: Emery Co., T16S, R14E, S05, NE 1/4, SE 1/4, Book Cliffs, Horse Canyon, ca. 0.4 km on rd. to cliff base, SW aspect, 1890 m, 18 Aug. 1985, *F. J. Smith 2702* [F. J. Smith collection 2700 distributed as type] (holotype, BRY; isotypes, NY, OSC, RENO, RM, UTC).

Distribution and habitat. *Mentzelia librina* is a narrowly distributed endemic of the Book Cliffs in Emery and Carbon counties, Utah, at 1700–2000 m elevation.

Relationships. *Mentzelia librina* is most closely related to *M. shultziorum*, which is found south of the Book Cliffs near the Colorado River on steep slopes that rise to the La Sal Mountains in Grand County, Utah. The monophyly of the two species is strongly supported by DNA sequence data (Schenk & Hufford, in prep.). The median antesepalous stamens of *M. librina* are obovate and taper abruptly to a basal claw; these are similar to those of *M. shultziorum*, although the latter have a broader claw. The leaves of *M. librina* differ from the other varieties of *M. multicaulis* by having a broader rachis with long dentate lobes (Fig. 1F). The leaves of *M. shultziorum* are much broader than *M. librina*, with ovate to obovate laminas and dentate margins (Fig. 1G).

Additional specimens examined. U.S.A. **Utah:** Emery Co., at base of Book Cliffs just N of mouth of Horse Canyon, 0.8 km NW of where State Rte. 124 terminates, along abandoned railroad tracks, 10 km air distance SSE of Dragerton, *N. H. Holmgren & P. K. Holmgren 14462* (NY, RENO, UNLV, UTC, WS); just S of Columbia & below railroad grade, *J. Anderson 85-124* (UTC); CC Summerville, 13 mi. NNW from Green River, Beckwith Plateau, *S. Welsh & K. Taylor 15218* (NY). Carbon Co., E of unimproved rd. located NE of mile marker 2 on Rte. 124, SE of East Carbon City, below abandoned railroad, *J. Schenk 1865* (WS).

4. **Mentzelia uintahensis** (N. H. Holmgren & P. K. Holmgren) J. J. Schenk & L. Hufford, stat. nov. Basionym: *Mentzelia multicaulis* (Osterhout) J. Darlington var. *uintahensis* N. H. Holmgren & P. K. Holmgren, Syst. Bot. 27: 758. 2002. TYPE: U.S.A. Utah: Uintah Co., Uinta Basin, Watson-Rainbow Rd., 2.3 km SE of State Rte. 45 & 1.1 km E of Evacuation Creek bridge, 63 km air distance SE of downtown Vernal, 1600 m, 13 July 2001, *N. H. Holmgren & P. K. Holmgren 14465* (holotype, NY; isotypes, ARIZ, BRY, COLO, ID, NY, RENO, RM, UTC, WS).

Distribution and habitat. *Mentzelia uintahensis* is among the most widely distributed of the aforementioned species, occurring on the Colorado Plateau from Carbon, Duchesne, and Uintah counties, Utah, east to Rio Blanco, Grand, Mesa, and Moffat counties, Colorado. Individuals occur mostly on rocky cliffs or road-cuts of white shale or loose talus at 1575–2750 m elevation. Its location and habitats are generally continuous with those of *M. librina*, and *M. uintahensis* is sister to the clade consisting of *M. librina* and *M. shultziorum*.

Relationships. The median antesepalous stamens of *Mentzelia uintahensis* are flabellate and have bases that narrow abruptly to a claw, which also characterizes the median antesepalous stamens of *M. librina* and *M. shultziorum*, although in the latter the claws are not as prominently narrowed. The basal leaves of *M. uintahensis* (Fig. 1H) are larger than those of the other species discussed here and have pinnate lobes that are much longer than those of *M. flumensevera* or *M. shultziorum*.

Additional specimens examined. U.S.A. **Colorado:** Rio Blanco Co., Piceance Creek Rd., at mouth of Cascade Gulch, 16.9 km NW of Rio Blanco, *N. H. Holmgren & P. K. Holmgren 14482* (NY, UTC); Piceance Creek Rd., 5.5 km S of State Rte. 64, *N. H. Holmgren & P. K. Holmgren 14475* (NY, UTC); Piceance Creek Rd., 15.1 km S of State Rte. 64, *N. H. Holmgren & P. K. Holmgren 14476* (NY, UTC, WS); Piceance Creek Rd., across rd. from Piceance Creek Ranch, 18.3 km NW of Rio Blanco, *N. H. Holmgren & P. K. Holmgren 14480* (NY, UTC, WS); Piceance Creek Rd., ca. 9 mi. below Rio Blanco, *W. A. Weber 17809* (UTC); 11 mi. W of Rio Blanco on Piceance Creek, *T. Beegle 766* (UTC); Piceance Creek near mouth of Cascade Gulch, Hwy. 26, *S. Goodrich 23158* (NY, UTC); on a road-cut along Co. Rd. 122 just W of jct. w/Co. Rd. 24, *P. Lyon 9176* (NY); Story Gulch, 0.3 mi. SE of Piceance Creek Ranch, *J. Walker & S. Sigstedt 82-334* (NY); along Piceance Creek Rd., 9.5 mi. NW of jct. w/Hwy. 13 at Rio Blanco, *L. Hufford 4137* (WS); W of Rio Blanco, Piceance Creek Rd., 6 mi. W from its intersection w/ Rte. 13, *J. Schenk 961* (WS). Moffat Co., 1/2 mi. up the Yampa River from confluence of Green & Yampa Rivers in Echo Park, *N. H. Holmgren et al. 469* (NY, UTC). Mesa Co., Grand Junction, May 1892, *A. Eastwood* (NY), *M. E. Jones 5472* (NY). Grand Co., 1 mi. E of Hot Sulphur Springs, *H. D. Ripley & R. C. Barneby 10504* (NY). **Utah:** Carbon Co., 1.6 mi. NE of Mt. Bartles Summit, S of Nine Mile Canyon, *E. Neese & L. England 6181a* (BRY). Uintah Co., 14 mi. due S of Ouray, *S. Welsh et al. 14395* (M, UTC); Split Mountain Gorge Campground, Dinosaur Natl. Monument, *K. S. Dever & R. A. Wolf 5280* (UTC); Ouray-Rainbow Rd., 37 mi. SE of Ouray at jct. of rd. along ridge betw. Sweetwater Canyon & Main Canyon, *N. H. Holmgren et al. 2270* (ID, NY, UTC); Klondike Canyon, *J. S. Peterson 1470* (NY, UTC); above Green River, E from Sand Wash Ferry, 6 mi. W of Wrinkles Rd., *L. M. Shultz & J. S. Shultz 3798* (NY, UTC); Southam Canyon Quadrangle, 30 July 1975, *J. Baker* (UTC); Uinta Basin, rd. from Bonanza to Watson, 1 km E of Evacuation Creek bridge, *N. H. Holmgren & P. K. Holmgren 14608* (NY, UTC); Uinta Basin, Watson-Rainbow Rd., 0.5 km S of State Rte. 45 & 0.6 km N of Evacuation Creek bridge, 62.5 km air distance SE of downtown Vernal, *N. H. Holmgren & P. K. Holmgren 14466* (NY, UTC, WS); Uinta Basin, 6.5 km air distance SSE of Bonanza, overlooking confluence of Evacuation Creek & White River, *N. H. Holmgren & P. K. Holmgren 14492* (ID, NY, RENO, UNLV, UTC, WS); Dugway in upper Three Mile Canyon, W of Evacuation Creek, Book Cliffs, *N. D. Atwood 30480* (RENO); Hell's Hole Canyon, SE of Bonanza, *N. D. Atwood 20471* (RENO); E Tavaputs Plateau, Big Pack, Little Pack Mtn., 24 mi. & 185 degrees from Ouray, *S. Goodrich & D. Atwood 14686* (NY); ca. 4 mi. W of Maeser, along Utah Hwy. 245, *S. L. Welsh & G. Moore 6750* (NY); Hell's Hole Canyon, 1.5 mi. W of Colorado–Utah border, *K. Thorne & B. Neely 1935* (NY); E base of Blue Mtn., head of Cub Creek, *E. Neese & C. Fullmer*

11750 (NY); Uinta Basin, rd. into Hell's Hole Canyon, 1.4 km down rd. from Bonanza-Watson rd., 9.5 km air distance SE of Bonanza, *N. H. Holmgren & P. K. Holmgren 14495* (NY); clay hills by Thorne Ranch, Willow Creek, *N. D. Atwood 1564* (NY); on white shale banks along Evacuation Creek 2 mi. S of White River, *H. D. Ripley & R. C. Barneby 8735* (NY); 15 mi. S of Bonanza & 1.3 mi. W of Colorado border, *E. Neese et al. 11659* (NY); Weaver Ridge E of White River, *N. D. Atwood 30475a* (NY, UNM); Hell's Hole Canyon, SE of Bonanza, *N. D. Atwood 30471* (NY); 37 mi. S of Ouray, *R. C. Barneby 13155* (NY); W of Vernal, Rte. 121, 7.9 mi. W of intersection w/Hwy. 191, *J. Schenk 1526* (WS). Duchesne Co., 3.5 mi. N of Nine Mile Canyon jct. w/Myton Rd., thence ca. 20 mi. E on dirt rd., *N. D. Atwood 2665* (NY); W Tavaputs Plateau, Wrinkle Rd., 11.7 km E of Myton-Wellington rd., 40 km air distance SSW of Myton, *N. H. Holmgren & P. K. Holmgren 13233* (NY).

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